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3 **TITLE:** Robotic surgery approach to incarcerated inguinoscrotal hernia: Case
4 presentation and literature review

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24 **Short Running Title:** Treatment of Incarcerated Inguinal Hernia

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27 submission.

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34 presentation and literature review

35

36 **ABSTRACT**

37

38 **Introduction**

39 Repair of inguinal hernias is one of the most common procedures performed by
40 general surgeons today. Specifically, management of incarcerated inguinal
41 hernias currently open tension free repair followed by laparoscopic approaches
42 (transabdominal preperitoneal and totally extraperitoneal) is the most prevalent.
43 More recently, the application of robotic platform Da Vinci Surgical System has
44 permutated every aspect of general surgery including hernia surgery. We describe
45 our experience with robotic approach to repair of incarcerated inguinoscrotal hernia.

46

47 **Case Report**

48 We present an 81-year-old male with 3-year history of reducible right inguinal hernia
49 that presented to the emergency department with inability to reduce the hernia. He
50 was subsequently diagnosed with right incarcerated inguinoscrotal hernia and
51 recommended to undergo surgical intervention. Robotic surgical approach was
52 chosen for repair of his hernia. Patient underwent successful robotic repair with
53 mesh of right incarcerated inguinoscrotal hernia and had an unremarkable post24
54 operative course.

55

56 **Conclusion**

57 The 3D high definition imaging and superior dissection control of the robotic platform
58 Da Vinci Surgical System affords the surgeon unique advantage in approaching
59 incarcerated inguinal hernias. Although, currently open and laparoscopic approaches
60 are more prevalent, the robotic approach is safe and effective option.

61

62 **Keywords:** Robotic TAPP; Robotic hernia repair; Robotic incarcerated 32 inguinal
63 hernia, Robotic herniorrhaphy, Inguinoscrotal hernia, Robotic surgery

64

65 **TITLE:** Robotic surgery approach to incarcerated inguinoscrotal hernia: Case
66 presentation and literature review

67

68 **INTRODUCTION**

69 Today the inguinal hernia repair is one of the most common procedures performed
70 by surgeons in the world. Management of inguinal hernias dates back to ancient
71 Egypt and was first described in 1500 BC. Over the years the surgical approach to
72 inguinal hernia has evolved along with the technological innovations of mankind.

73 Currently, open tension free repair of incarcerated inguinal hernia is most prevalent
74 however laparoscopic transabdominal preperitoneal (TAPP) and totally
75 extraperitoneal (TEP) approach have been well validated in numerous studies. The
76 robotic platform Da Vinci Surgical System is a newest innovation of minimally
77 invasive surgery. The robotic platform has been widely adopted in general surgery
78 including repair of incarcerated inguinal hernias. We describe our experience with
79 robotic approach to incarcerated inguinoscrotal hernia as well review the current
80 literature.

81

82 **CASE REPORT**

83 An 81-year old male with a chronic history of right inguinal hernia presented to the
84 ED. Patient has had the hernia for 3 years, however became concerned when he no
85 longer was able to actively reduce the hernia. Further questioning revealed that the
86 hernia has been incarcerated for 1 week. Originally painless, now patient described
87 aching pain sensation with dragging-like pressure in the groin that has gradually
88 gotten worse. He denied nausea, emesis, fever or chills and admitted to having
89 regular bowel movements. Past medical history was significant for hypertension,
90 diabetes mellitus, and hyperlipidemia. Medications taken for his comorbidities
91 include Lisinopril, Atorvastatin, Nifedipine and Insulin. Past surgical history was only
92 significant for Cataracts. Physical examination revealed an incarcerated but not
93 strangulated right inguinoscrotal hernia. The hernia mass was non-reducible and
94 obscured the normal spermatic cord structures. There were no skin changes,
95 including discoloration or retractions, and no palpable inguinal lymph nodes. Digital
96 rectal exam revealed an empty rectal vault and no intraluminal masses.

97 Laboratory studies did not demonstrated leukocytosis. Computed tomography scan
98 of the abdomen and pelvis without contrast showed fluid containing right
99 inguinoscrotal hernia that measured about 5 cm in AP diameter. There was no bowel
100 present in the hernia sac and the fluid measured in the sac was about 18 Hounsfield
101 units. (Figure 1-3) Patient was taken to the OR for a robotic repair of incarcerated
102 right inguinoscrotal hernia with mesh. Standard antiseptic technique was used to
103 prep the patient and a total of three port site incisions were made for the Da Vinci
104 robot arms to dock and enter. The patient was placed in Trendelenburg position and
105 robotic 8-mm trocars were placed in each anterior axillary line and a 30-degree
106 camera was placed in the up position in the umbilical port. The robot was docked in
107 the standard fashion. The right inguinal region was visualized and the peritoneum
108 was scored from the medial umbilical fold laterally to the anterior superior iliac spine.
109 A preperitoneal flap was created by dissecting the peritoneum away from the
110 spermatic cord and vas deferens anteriorly with the hook electrocautery. Medially,
111 coopers ligament was identified and no direct hernia was appreciated. The
112 incarcerated indirect inguinoscrotal hernia containing preperitoneal fat was carefully
113 dissected off the cord structures and reduced. Lipoma removed from the abdomen
114 as passed off the field for pathology. Covidien ProGrip self-fixating mesh was used
115 to cover the preperitoneal space overlying indirect defect as well as the rest of the
116 potential hernia sites. The peritoneal flap was closed with a running 6-inch V-Loc
117 suture. Patient was extubated in the OR and discharged home the same day after a
118 non114 complicated postoperative course.

119

120 DISCUSSION

121 There are multiple techniques that are used to repair incarcerated inguinal hernias.
122 The open approach has been used the longest, but there are newer and more
123 desired techniques that are now becoming available. The laparoscopic approach in
124 general is a well-studied and desired method by surgeons and patients for correcting
125 incarcerated inguinal hernias. Laparoscopic techniques for repairing inguinal hernias
126 can be divided into the totally extra-peritoneal (TEP) procedure and the trans123
127 peritoneal (TAPP) procedure. Choosing which technique depends on surgeon

128 preference or surgeon experience, and there are various case scenarios that have
129 been conducted and published using each technique. [5]

130 The open technique to repair incarcerated inguinal hernias has been around the
131 longest and is preferred by the surgeons who have been practicing for many years.

132 One study measured 49,657 patients who underwent an inguinal hernia repair
133 between 2007 and 2011 in Quebec, Canada. 56% of these cases were performed
134 using an open technique and 8% were performed using the laparoscopic technique.

135 This study showed that an open approach is favored for all clinical scenarios, even
136 for situations where published guidelines recommend a laparoscopic approach.

137 Surgeons remain divided on the best technique for inguinal hernia repair: while more
138 than half never perform LIHR, the small proportion who perform many use the
139 technique for a large proportion of their cases. There appears to be a gap between
140 the best practices put forth in guidelines and what surgeons are doing in actual
141 practice and that surgeon would benefit in educational programs to train those who
142 have the desire to explore new surgical techniques. [7]

143 To add, there have been many reputable studies conducted using the totally
144 extra140 peritoneal (TEP) procedure. One study included 4565 laparoscopic TEP
145 hernia repairs between January 2001 and January 2011 with 27 complications and 2
146 deaths which showed that the rate of TEP complications is low, but the TEP
147 technique must be meticulous to avoid intraoperative complications. [4] Another
148 study used data from a 6-year prospective study that evaluated the TAPP repair
149 procedure for both chronically and acutely incarcerated hernias. An accompanying
150 resection therapy became necessary for only four of the emergency cases (11.1%)
151 and two of the chronically incarcerated cases (1.3%) in the TAPP group.
152 Postoperative morbidity was 2.8% in the emergency group and 3.8% in the
153 chronically incarcerated group, which does not differ from the rate for TAPP used on
154 reducible hernias. [3].

155 In addition to the laparoscopic and open approaches to repairing incarcerated
156 inguinal hernias, surgeons have recently been starting to transition to the robotic
157 approach, which has many advantages and has proven to be a feasible and safe
158 alternative.

159 One study using the robotic technique to repair incarcerated inguinal hernias
160 measured the results of 123 hernia repairs, forty-five of those being done using a
161 robotic approach. Surgical complications included a hematoma in three patients, two
162 seromas and one superficial surgical site infection at a trocar site, which resolved
163 with oral antibiotics. Chronic postoperative complications included the persistence of
164 hematomas in two patients. Same day discharge was achieved in 60 patients with a
165 mean length of stay of 8 hours. Neither mortality nor conversion to open surgery
166 occurred. This study showed that robotic repair of inguinal hernias is safe and
167 versatile, which allows the surgeon to perform this procedure in more complex cases
168 such as those involving incarcerated and/or recurrent hernias. [2]

169 Another study reported a series of 16 patients who underwent robotic single-port
170 total extraperitoneal inguinal hernia repair compared to 16 cases of conventional
171 single-port inguinal hernia repair. Although operation time was comparable in both,
172 the time wasted for scope cleaning was 8.5 minutes for conventional compared to
173 1.5 minutes for robotic surgery, which shows that robotic surgery for inguinal repairs
174 is feasible and efficient. [6]

175 A recent case report was published that followed the case of a 53-year old man who
176 underwent a robotic-assisted laparoscopic repair of a giant incarcerated recurrent
177 inguinal hernia that contained bladder and ureters. During the procedure, the bladder
178 and both ureters were carefully dissected free from the scrotum, while preserving the
179 testicle and spermatic cord. A 6x4 inch pre-peritoneal polyester composite mesh was
180 then used to repair the defect. This case concluded that inguinal hernias are
181 challenging, but the robotic approach allows for fine dissection and is an excellent
182 alternative to open surgery. [1]

183 **CONCLUSION**

184 Overall, there are many techniques available for the repair of incarcerated inguinal
185 hernias, which have been proven to be reliable and effective. The open and
186 laparoscopic (TEP and TAPP) techniques have been around longer and studied
187 most. However, the robotic technique with advanced 3D high-definition imaging and
188 superior dissection control has demonstrated to be a safe and viable option in
189 approach to repair of incarcerated inguinoscrotal hernia.

190

191 **CONFLICT OF INTEREST**

192 No financial interest or any conflict of interest to exist.

193

194 **AUTHOR'S CONTRIBUTIONS**

195 Thomas J. Shaknovsky, DO

196 Group1 - Conception and design, Acquisition of data, Analysis and interpretation of
197 data

198 Group 2 - Drafting the article, Critical revision of the article

199 Group 3 - Final approval of the version to be published

200

201 Lance U. Jung MD, FACS

202 Group 3 - Final approval of the version to be published

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204 Seth Iskowitz, BS

205 Group1 - Acquisition of data, Analysis and interpretation of data

206

207 Zahra Beizaeipour, BSc, MS

208 Group1 - Acquisition of data

209

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212

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238

239 SUGGESTED READING

240

241 Video

242 Robotic Repair of Right Inguinal Scrotal Hernia:
243 <https://www.youtube.com/watch?v=uD5dRr48Bzo>

244

245 FIGURE LEGENDS

246

247 Figure 1 – 3: Computed tomography scan of abdomen and pelvis without contrast
248 identifying right incarcerated inguinoscrotal hernia (A).

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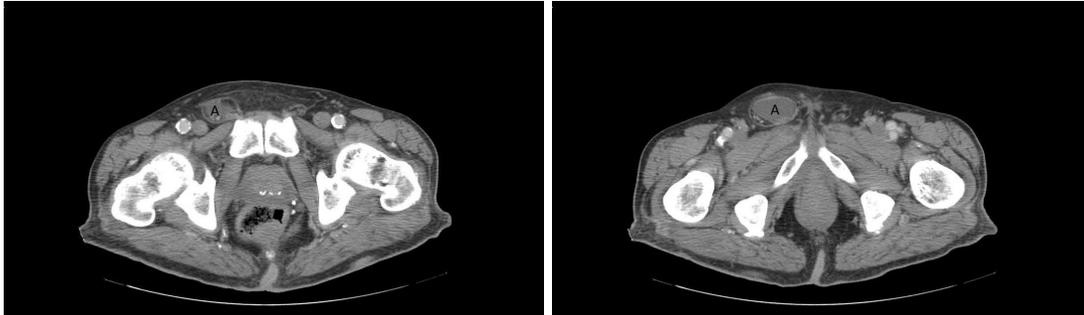
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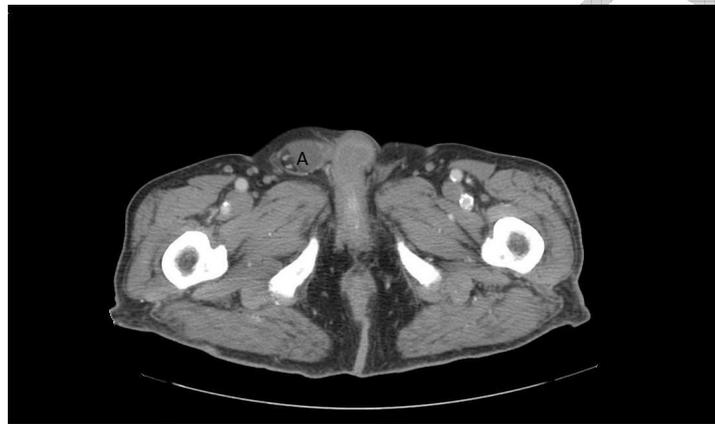
254 **FIGURES**

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